Section 5
Risk Characterization

Risk characterization is the final step in the risk assessment process. In this step, toxicity information is combined with estimates of dose to yield quantitative estimates of cancer risk and noncancer hazard.

5.1 Overview of Noncarcinogenic Hazard Characterization

Noncarcinogenic hazard is measured in terms of a Hazard Quotient (HQ). The HQ is defined by the equation:

$$\mathbf{HQ = ADD / RfD}$$

where:

HQ	=	Hazard Quotient associated with the exposure via the specified exposure route (unitless)
ADD	=	Average Daily Dose (in mg/kg/day)
RfD	=	Reference Dose (in mg/kg/day)

or, for inhalation exposures:

$$\mathbf{HQ = [OHM]air / RfC}$$

where:

[OHM]air	=	exposure point concentration of the oil or hazardous material in air (in µg/m^3)
RfC	=	Reference Concentration or substitute toxicity value for chemical (in µg/m^3)

In evaluating the HQ, potential toxicities of individual chemicals within a mixture are assumed to be additive. Thus, HQs attributable to individual chemicals are generally summed for each receptor to obtain a cumulative hazard index (HI). Such addition is not applicable for this assessment because total PCBs are assessed as a single chemical entity for toxicological purposes.

A cumulative HI also represents the cumulative noncarcinogenic impact that the site has on a particular receptor group. The cumulative HI accounts for exposures that a receptor may receive from multiple chemicals and multiple exposure routes:

$$\text{Total } HI_{\text{route-specific}} = \sum HQ_{\text{chemical-specific}}$$

$$\text{Cumulative HI} = \sum HI_{\text{route-specific}}$$

The HQ is a unitless ratio of a receptor's exposure level (or dose) to the "acceptable" (or allowable) exposure level. A HI of 1 or less for exposure via all chemicals and routes, or a HQ of 1 or less in the event that only one contaminant and/or exposure route is/are assessed, indicates that the receptor's exposure is equal to or less than an "allowable" exposure level, and adverse health effects are considered unlikely to occur. When the cumulative HI is less than or equal to 1, a conclusion of "no significant risk of harm to human health" based on noncancer effects is appropriate. Both MDEQ and EPA have HI thresholds of 1. HQs were calculated for the various angler receptors, since only one contaminant (PCBs) and one exposure route (fish ingestion) were considered for this group of receptors. HIs were calculated for the residential and recreational receptors, however, due to the summation of HQs for the individual exposure routes of incidental ingestion, dermal contact, and inhalation of fugitive dust.

5.2 Overview of Cancer Risk Characterization

For potential carcinogens, cancer risks are obtained by the following equation:

$$\mathbf{Risk = LADD \times CSF}$$

where:

Risk	=	Excess Lifetime Cancer Risk associated with exposure to the chemical via the specified route of exposure
LADD	=	Lifetime Average Daily Dose (in mg/kg/day)
CSF	=	Cancer Slope Factor (in $[mg/kg/day]^{-1}$)

In evaluating the potential cancer risks, it is assumed that potential toxicity of chemical mixtures is additive.

MDEQ has established a cancer risk target value of 1 in 100,000 (10^{-5}). Where cumulative cancer risks exceed this threshold, MDEQ risk managers may determine that some action to reduce exposure and risk may be necessary. The MDEQ risk target falls in the middle to EPA's risk range of 1 in 1,000,000 (10^{-6}) to 1 in 10,000 (10^{-4}). EPA generally considers risks within this range "acceptable," but considerations such as size of affected population may indicate that some action to reduce risk is appropriate. Above this range, EPA risk managers will ordinarily determine that such action is necessary.

5.3 Estimation of Noncarcinogenic Hazard and Carcinogenic Risk

Estimated HQs and cancer risks for each of the seven study areas and three floodplain soil areas are presented in Figures 5-1 through 5-12 and Tables 5-1 through 5-6. The figures present only the hazard quotients/indices for the immunological endpoint, which were higher than those for the reproductive endpoint. Also, results for ABSAs

1 and 2, located upstream of API/PC/KR site sources, are included on the figures for comparative purposes. Hazard quotients/indices for both endpoints are presented in the tables. Separate estimates are presented for each of the angler scenarios, including:

- Subsistence anglers consuming 100 percent smallmouth bass (average and maximum concentrations)
- Subsistence anglers consuming 76 percent smallmouth bass and 24 percent carp (average and maximum concentrations)
- Sport anglers, high end anglers consuming 100 percent smallmouth bass (average and maximum concentrations)
- Sport anglers, high end anglers consuming 76 percent smallmouth bass and 24 percent carp (average and maximum concentrations)
- Sport anglers, CTE anglers consuming 100 percent smallmouth bass (average and maximum concentrations)
- Sport anglers, CTE anglers consuming 76 percent smallmouth bass and 24 percent carp (average and maximum concentrations)
- Residents and recreationalists living near Trowbridge, Plainwell, and Otsego Dam floodplain soils (average and maximum concentrations)

5.3.1 Subsistence Anglers

5.3.1.1 Cancer Risks

As presented on Tables 5-1 and 5-2 and Figures 5-1 through 5-4, cancer risks to subsistence anglers who ingested either 100 percent smallmouth bass or 76 percent smallmouth bass and 24 percent carp exceeded MDEQ and EPA cancer risk thresholds for both average exposure point concentrations (EPCs) and maximum EPC scenarios for all ABSAs in the API/PC/KR site. Cancer risks were in the range at or above 1 in 10,000 for study areas ABSA 3, 4, 5 (combined), ABSAs 6 and 11 for average concentrations, and ABSA 11 for maximum concentrations. Cancer risks were in the range at or above 1 in 1,000 for both average EPCs and maximum EPC scenarios for all other ABSAs. The highest cancer risks for the single species scenario was in ABSA 9, where cancer risks using maximum concentrations were estimated as 4 in 1,000. The highest cancer risks for the mixed species scenario were in ABSA 3, 4, 5 (combined), where risks using maximum concentrations were 5 in 1,000.

Range of Cancer Risk Estimates by ABSA and by Exposure Scenario Based on Average Concentrations of PCBs in Smallmouth Bass (100% of Consumption)

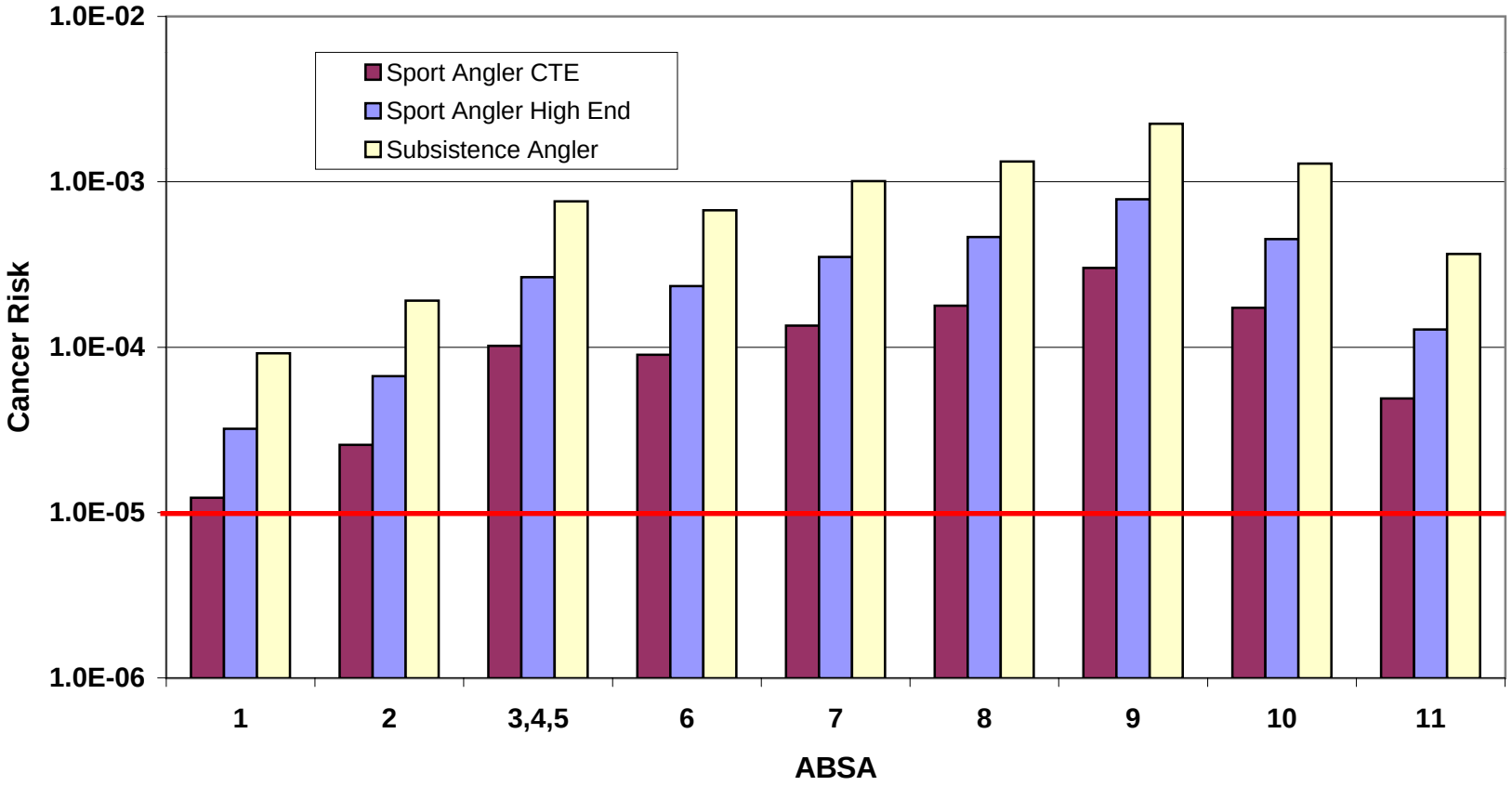

FIGURE 5-1

API/PC/KR SITE

Range of Cancer Risk Estimates by ABSA and by Exposure Scenario Based on Maximum Concentrations of PCBs in Smallmouth Bass (100% of Consumption)

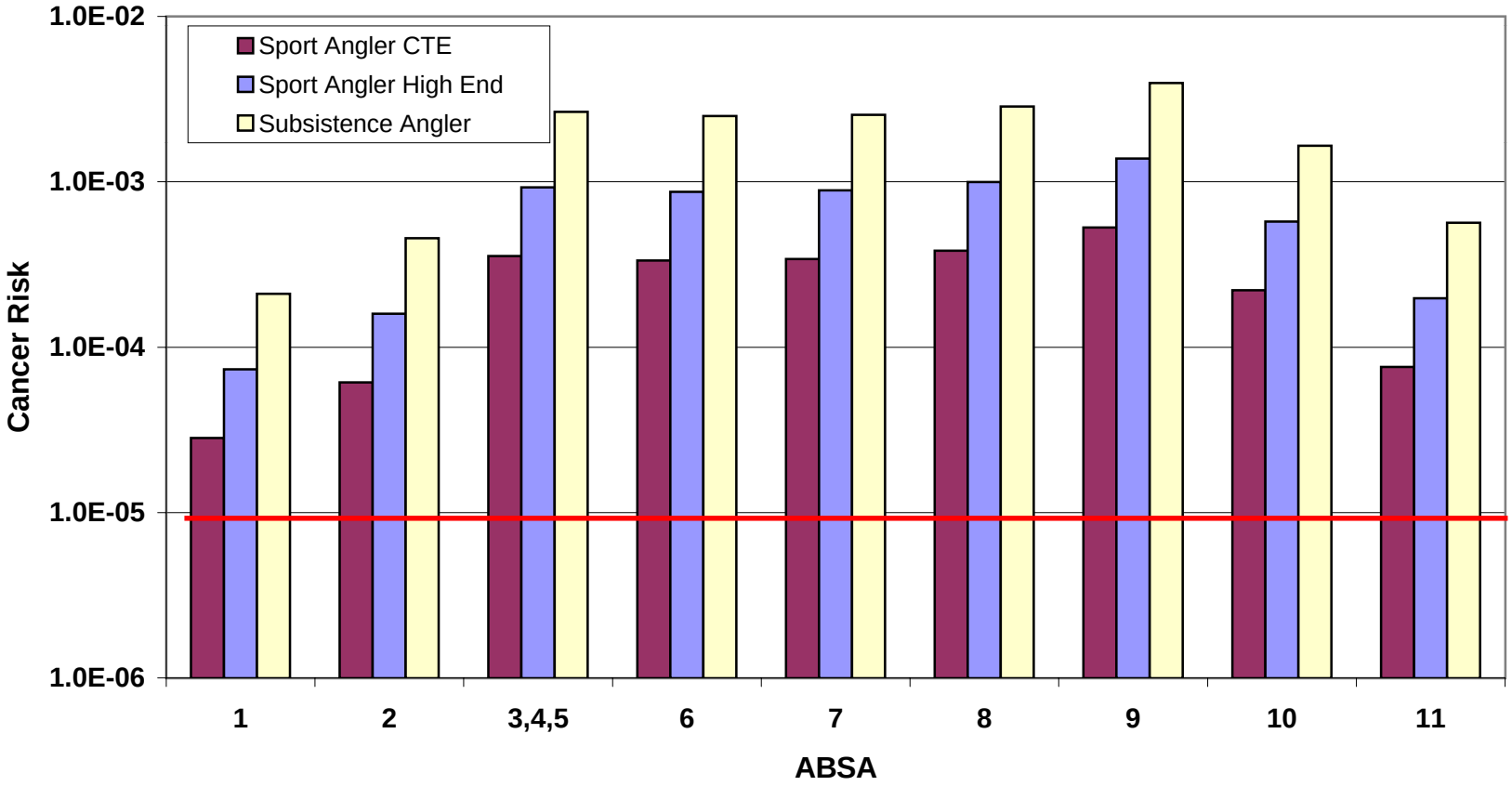

FIGURE 5-2

API/PC/KR SITE

Range of Cancer Risk Estimates by ABSA and by Exposure Scenario Based on Average Concentrations of PCBs in Smallmouth Bass (76% of Consumption) and Carp (24% of Consumption)

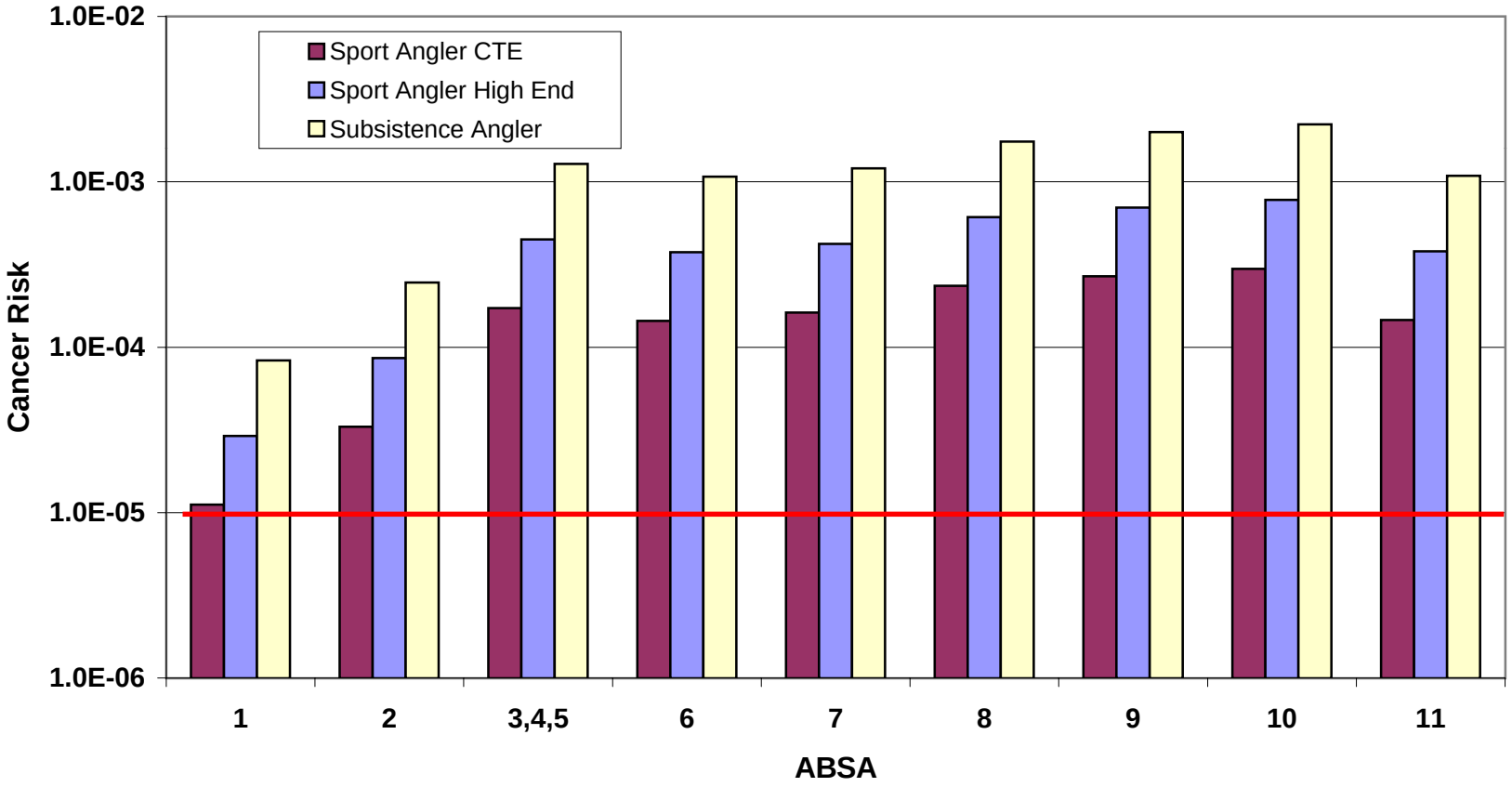

FIGURE 5-3

API/PC/KR SITE

Range of Cancer Risk Estimates by ABSA and by Exposure Scenario Based on Maximum Concentrations of PCBs in Smallmouth Bass (76% of Consumption) and Carp (24% of Consumption)

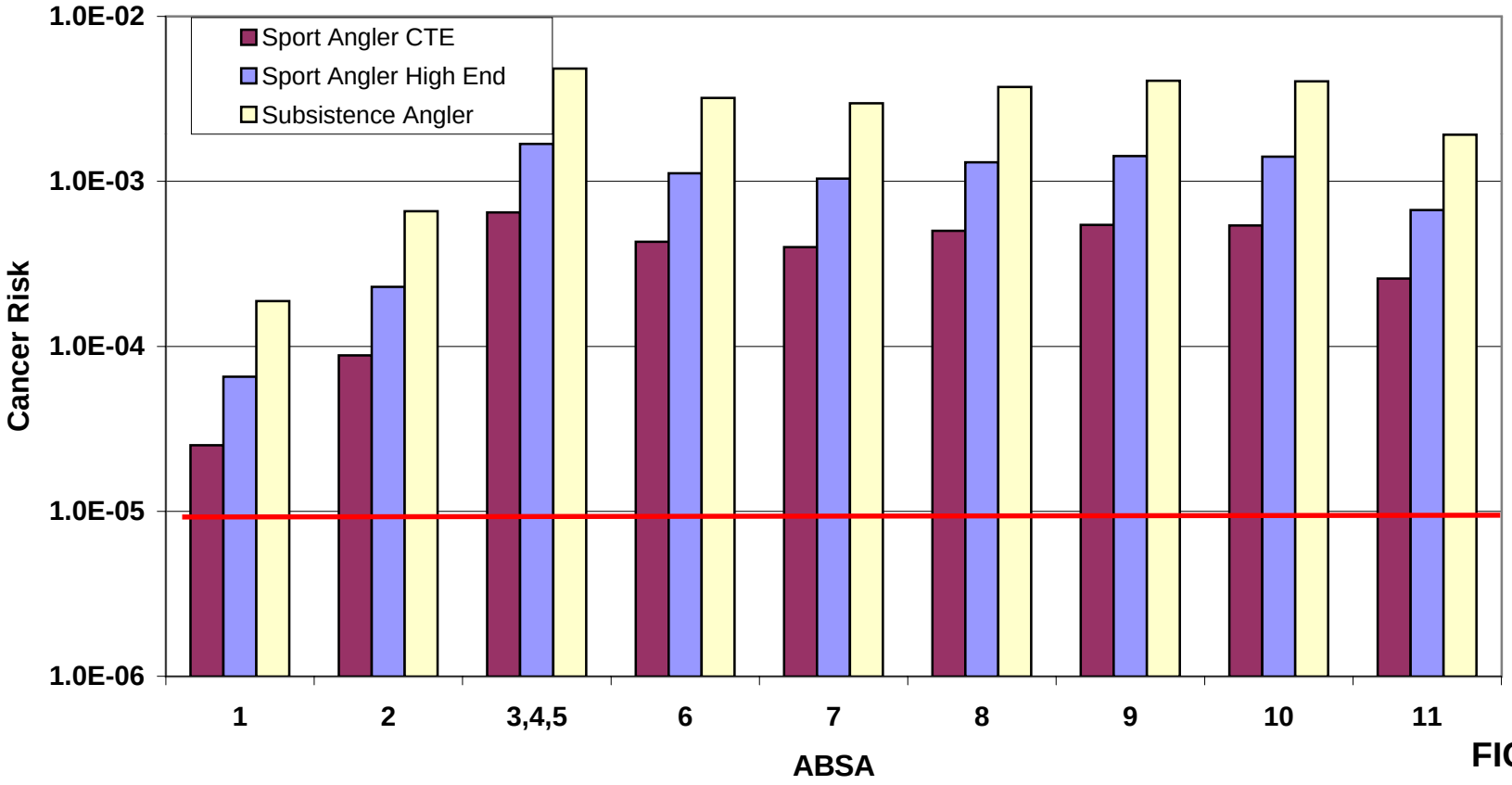

FIGURE 5-4

API/PC/KR SITE

Range of Hazard Estimates by ABSA and by Exposure Scenario Immunological Endpoint Based on Average Concentrations of PCBs in Smallmouth Bass (100% of Consumption)

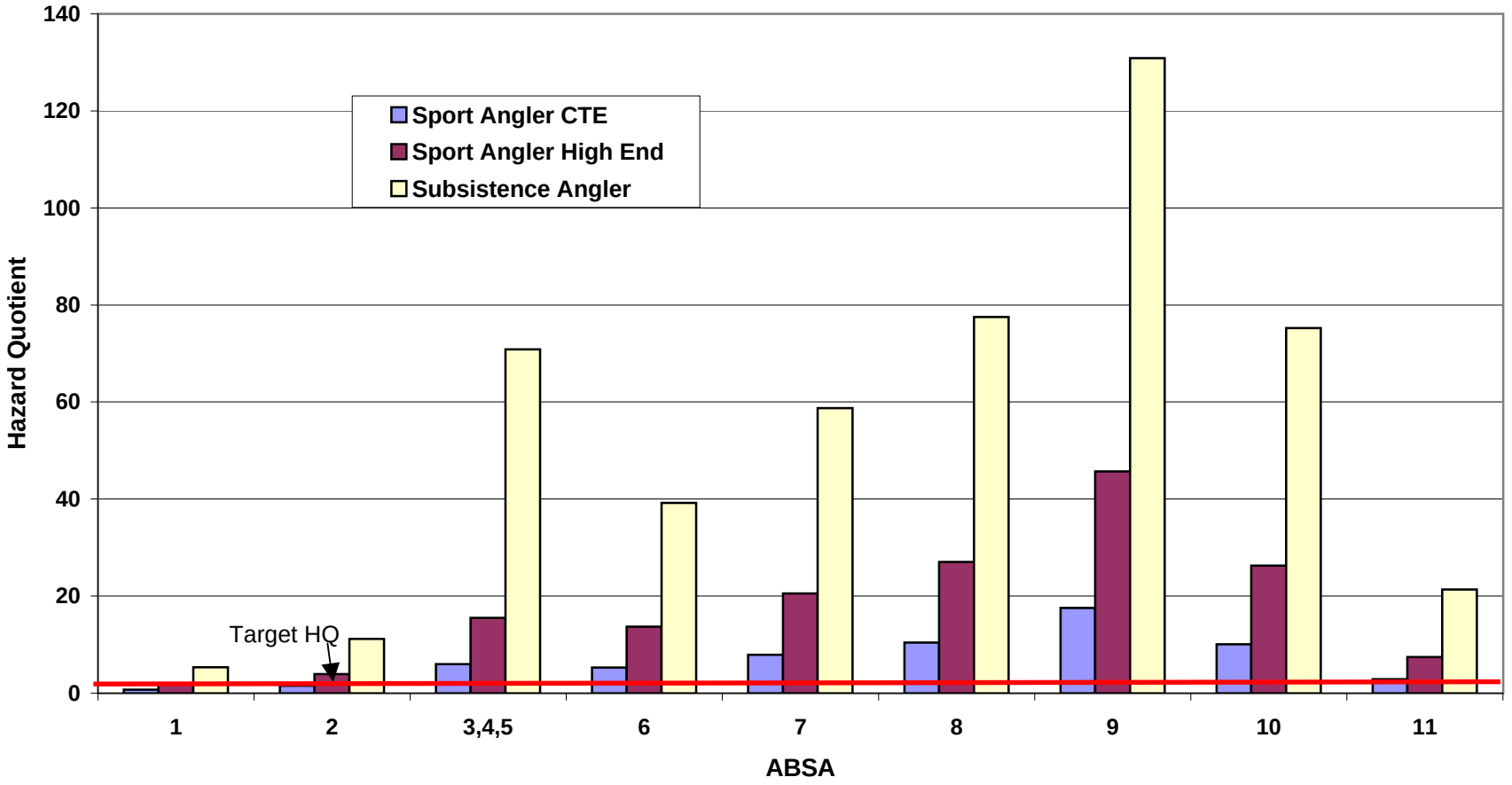

FIGURE 5-5

API/PC/KR SITE

Range of Hazard Estimates by ABSA and by Exposure Scenario Immunological Endpoint Based on Maximum Concentrations of PCBs in Smallmouth Bass (100% of Consumption)

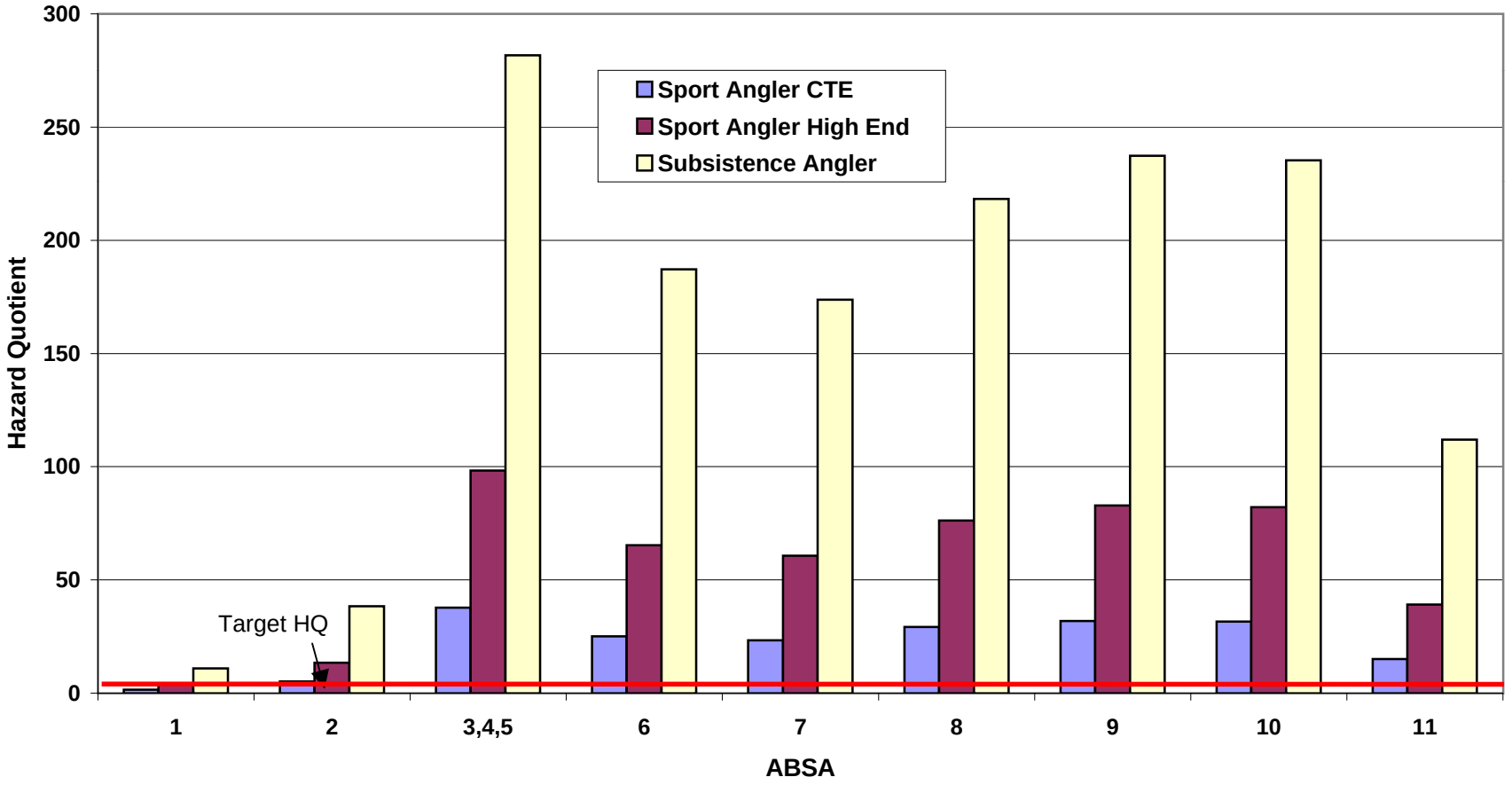

FIGURE 5-6

API/PC/KR SITE

Range of Hazard Estimates by ABSA and by Exposure Scenario Immunological Endpoint Based on Average Concentrations of PCBs in Smallmouth Bass (76% of Consumption) and Carp (24% of Consumption)

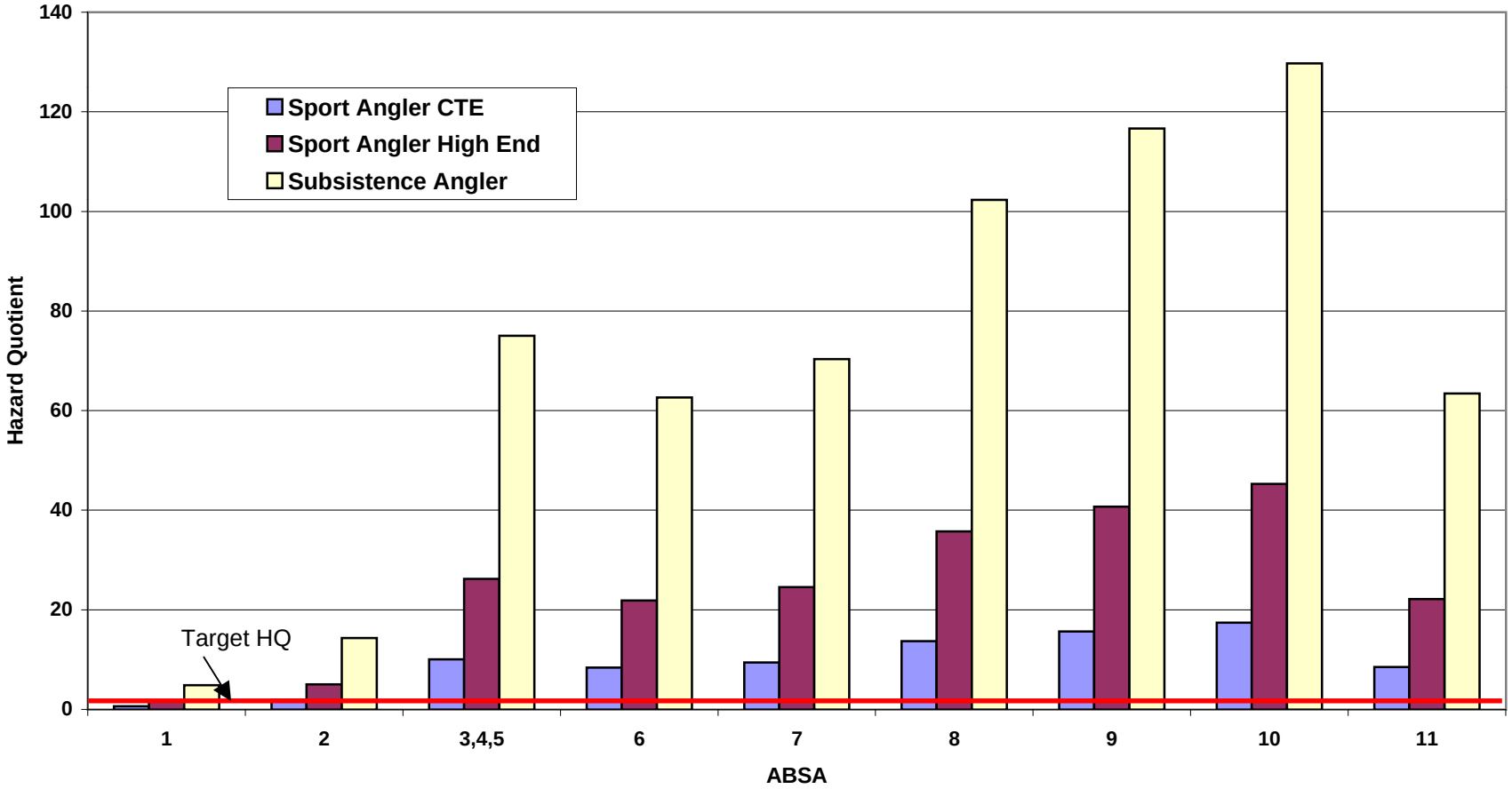

FIGURE 5-7

API/PC/KR SITE

Range of Hazard Estimates by ABSA and by Exposure Scenario Immunological Endpoint Based on Maximum Concentrations of PCBs in Smallmouth Bass (76% of Consumption) and Carp (24% of Consumption)

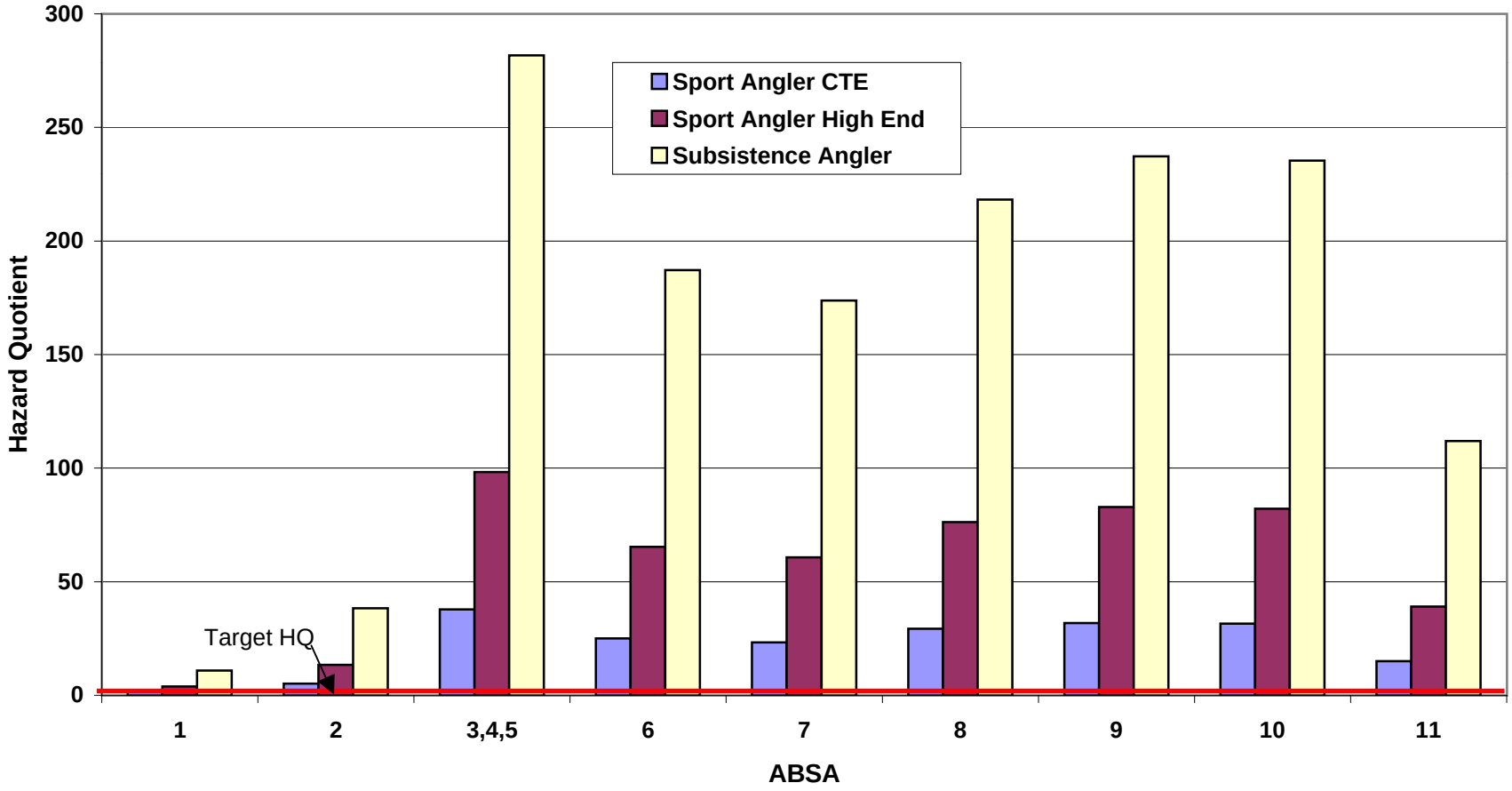

FIGURE 5-8

API/PC/KR SITE

Estimated Cancer Risks For Former Impoundment Areas
Residential Exposure Scenario

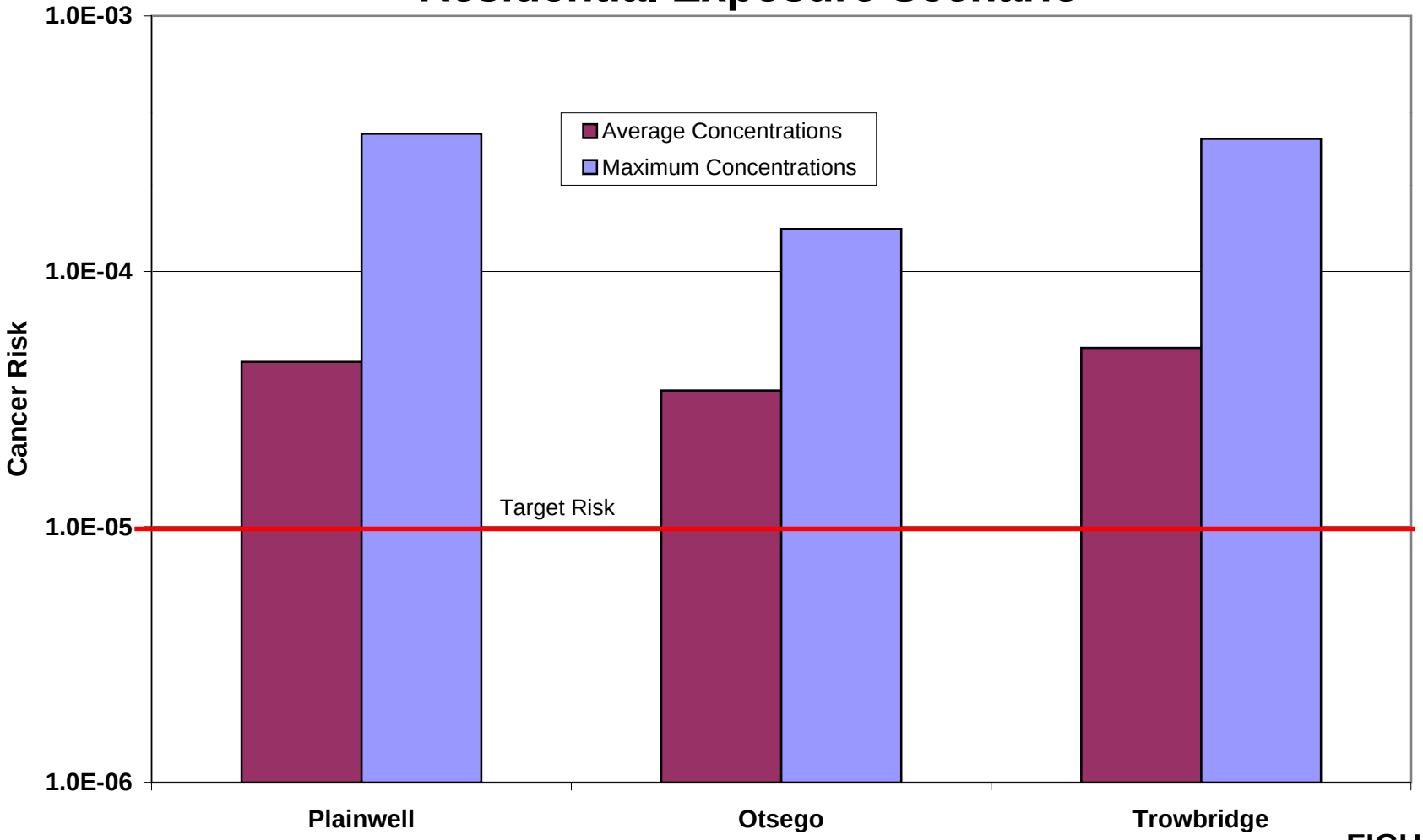

FIGURE 5-9

AP/PC/KR SITE

Estimated Non-Cancer Hazards for Former Impoundment Areas
Residential Exposure Scenario

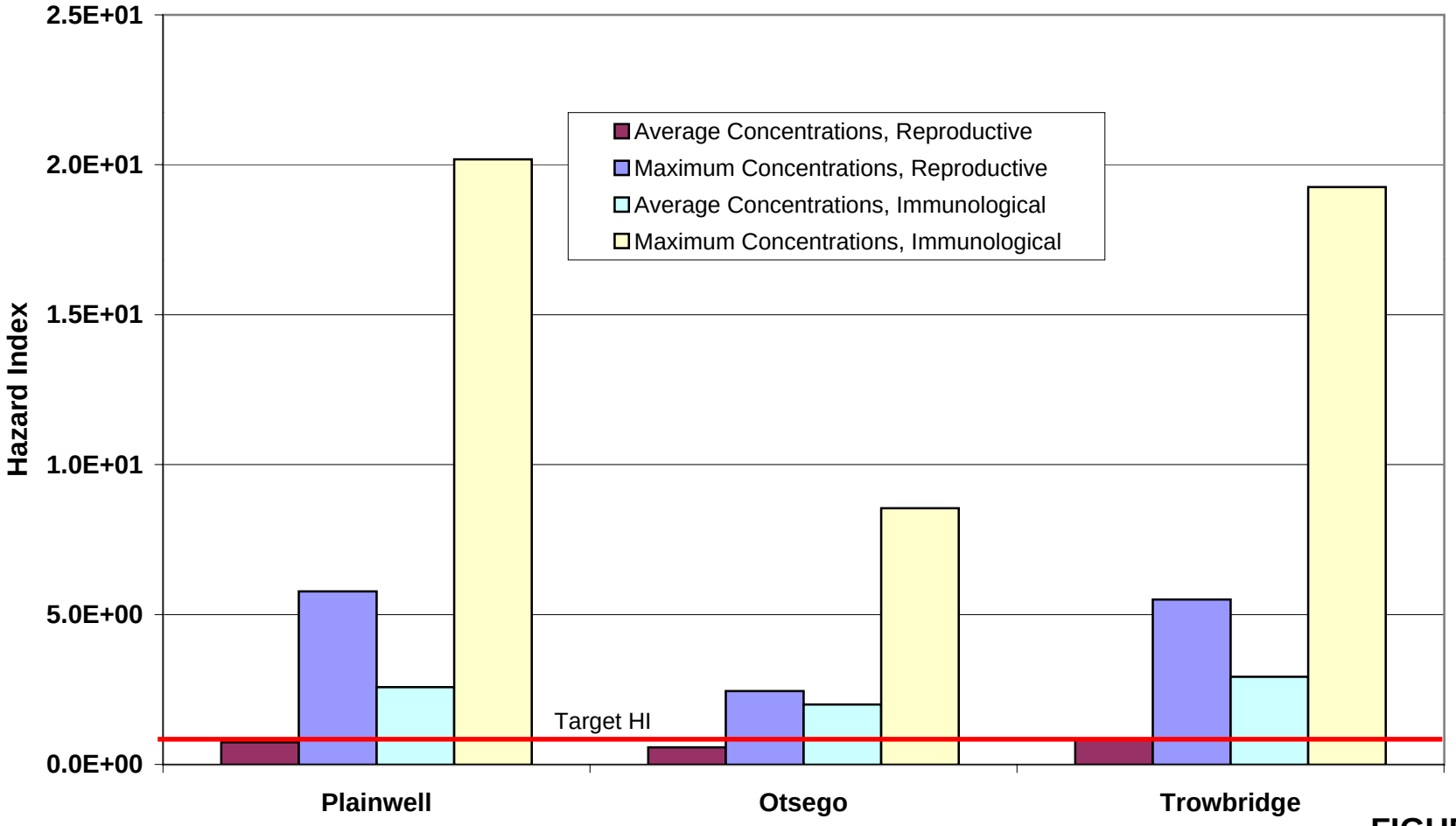

FIGURE 5-10

AP/PC/KR SITE

Estimated Cancer Risks for Former Impoundment Areas
Recreational Exposure Scenario

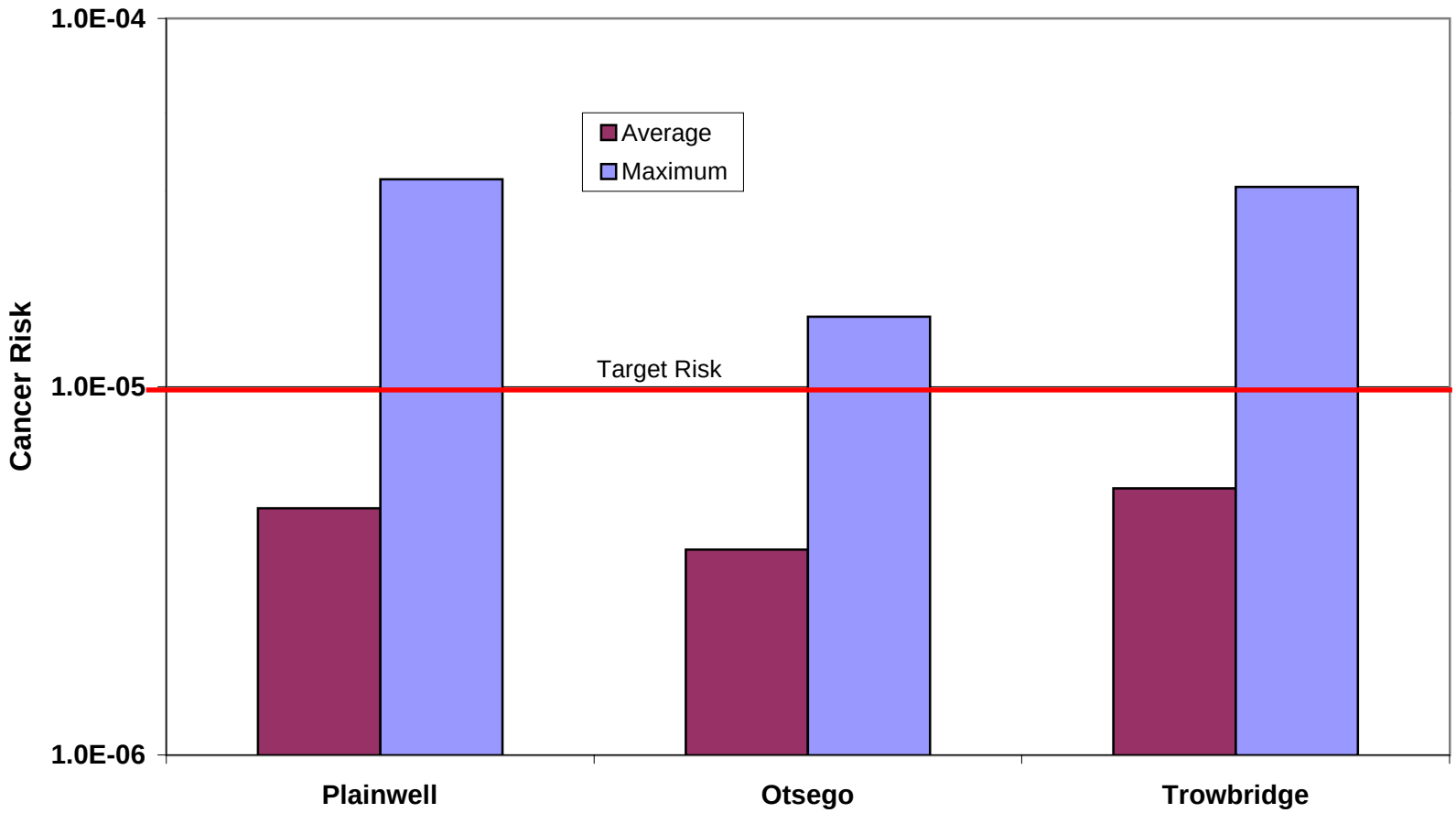

FIGURE 5-11

AP/PC/KR SITE

Estimated Non-Cancer Hazards for Former Impoundment Areas
Recreational Exposure Scenario

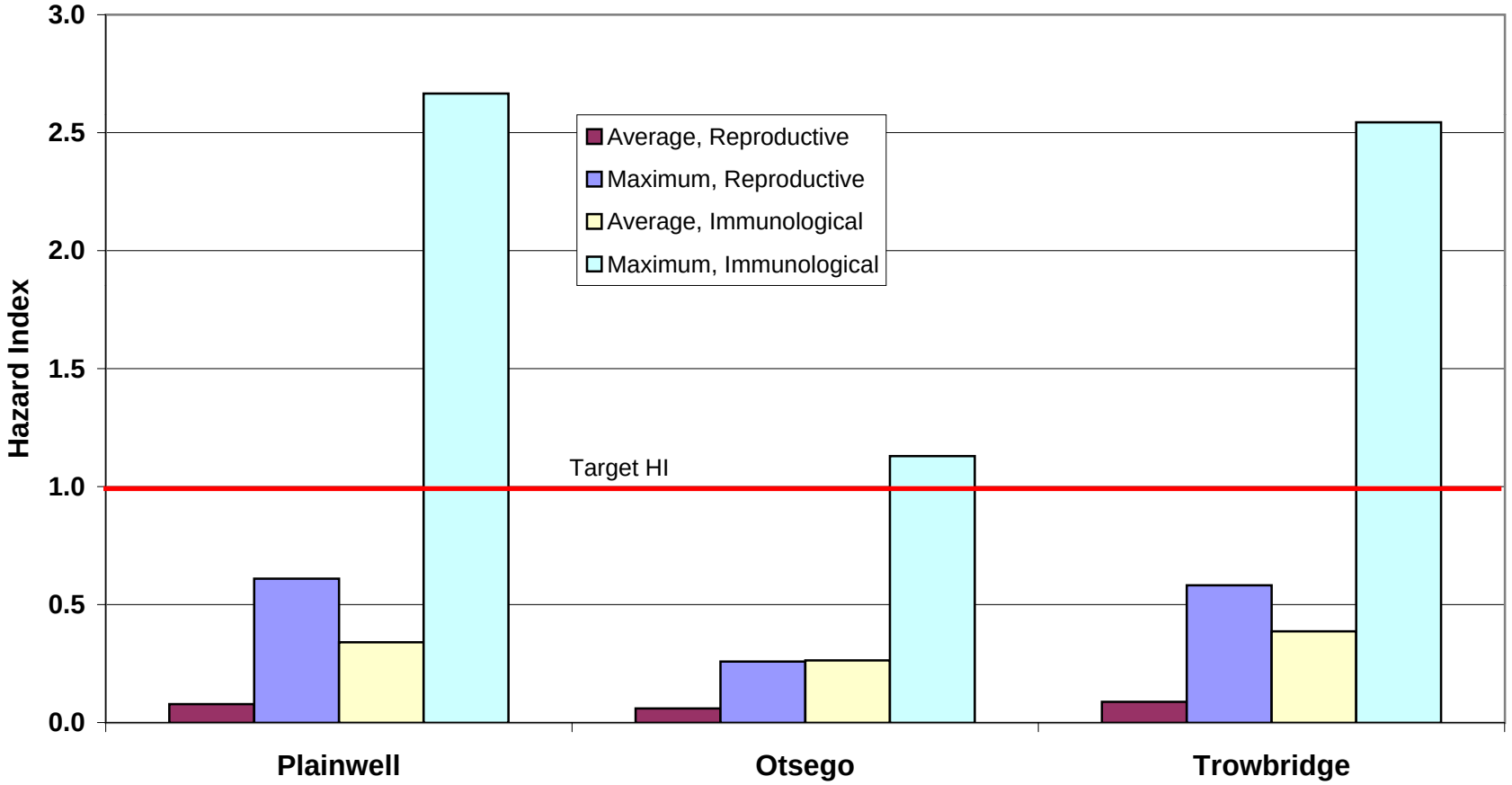

FIGURE 5-12

AP/PC/KR SITE

Table 5-1 Summary of Risks and Hazards for Subsistence and Sport Anglers Average Concentrations API/PC/KR Site

				Carcinogenic Risk from Ingestion of Fish					
				Subsistence		Sport - Central Tendency		Sport - High End	
Source Medium	Exposure Medium	Exposure Point	Chemical	100% SMB	76% SMB/ 24% CARP	100% SMB	76% SMB/ 24% CARP	100% SMB	76% SMB/ 24% CARP
Fish	Fish	ABSA 3,4,5 (Combined)	Total PCBs	7.6E-04	1.3E-03	1.0E-04	1.7E-04	2.7E-04	4.5E-04
		ABSA 6	Total PCBs	6.7E-04	1.1E-03	9.0E-05	1.4E-04	2.3E-04	3.7E-04
		ABSA 7	Total PCBs	1.0E-03	1.2E-03	1.4E-04	1.6E-04	3.5E-04	4.2E-04
		ABSA 8	Total PCBs	1.3E-03	1.8E-03	1.8E-04	2.4E-04	4.6E-04	6.1E-04
		ABSA 9	Total PCBs	2.2E-03	2.0E-03	3.0E-04	2.7E-04	7.8E-04	7.0E-04
		ABSA 10	Total PCBs	1.3E-03	2.2E-03	1.7E-04	3.0E-04	4.5E-04	7.8E-04
		ABSA 11	Total PCBs	3.7E-04	1.1E-03	4.9E-05	1.5E-04	1.3E-04	3.8E-04

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)

				Noncarcinogenic Hazard Quotient from Ingestion of Fish					
				Subsistence		Sport - Central Tendency		Sport - High End	
Source Medium	Exposure Medium	Exposure Point	Chemical	100% SMB	75% SMB/ 25% CARP	100% SMB	75% SMB/ 25% CARP	100% SMB	75% SMB/ 25% CARP
Fish	Fish	ABSA 3,4,5 (Combined)	Total PCBs	13 (R) 71 (I)	21 (R) 75 (I)	1.7 (R) 5.9 (I)	2.9 (R) 10 (I)	4.4 (R) 15 (I)	7.5 (R) 26 (I)
		ABSA 6	Total PCBs	11 (R) 39 (I)	18 (R) 63 (I)	1.5 (R) 5.3 (I)	2.4 (R) 8.4 (I)	3.9 (R) 14 (I)	6.2 (R) 22 (I)
		ABSA 7	Total PCBs	17 (R) 59 (I)	20 (R) 70 (I)	2.3 (R) 7.9 (I)	2.7 (R) 9.4 (I)	5.9 (R) 21 (I)	7.0 (R) 25 (I)
		ABSA 8	Total PCBs	22 (R) 77 (I)	29 (R) 100 (I)	3.0 (R) 10 (I)	3.9 (R) 14 (I)	7.7 (R) 27 (I)	10 (R) 36 (I)
		ABSA 9	Total PCBs	37 (R) 130 (I)	33 (R) 120 (I)	5.0 (R) 18 (I)	4.5 (R) 16 (I)	13 (R) 46 (I)	12 (R) 41 (I)
		ABSA 10	Total PCBs	21 (R) 75 (I)	37 (R) 130 (I)	2.9 (R) 10 (I)	5.0 (R) 17 (I)	7.5 (R) 26 (I)	13 (R) 45 (I)
		ABSA 11	Total PCBs	6.1 (R) 21 (I)	18 (R) 63 (I)	.82 (R) 2.9 (I)	2.4 (R) 8.5 (I)	2.1 (R) 7.5 (I)	6.3 (R) 22 (I)

Notes: Target hazard quotient: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

Table 5-2 Summary of Risks and Hazards for Subsistence and Sport Anglers Maximum Concentrations API/PC/KR Site

				Carcinogenic Risk from Ingestion of Fish					
				Subsistence		Sport - Central Tendency		Sport - High End	
Source Medium	Exposure Medium	Exposure Point	Chemical	100% SMB	76% SMB/ 24% CAR	100% SMB	76% SMB/ 24% CAR	100% SMB	76% SMB/ 24% CAR
Fish	Fish	ABSA 3,4,5 (Combined)	Total PCBs	2.7E-03	4.8E-03	3.6E-04	6.5E-04	9.3E-04	1.7E-03
		ABSA 6	Total PCBs	2.5E-03	3.2E-03	3.3E-04	4.3E-04	8.7E-04	1.1E-03
		ABSA 7	Total PCBs	2.5E-03	3.0E-03	3.4E-04	4.0E-04	8.9E-04	1.0E-03
		ABSA 8	Total PCBs	2.9E-03	3.7E-03	3.8E-04	5.0E-04	1.0E-03	1.3E-03
		ABSA 9	Total PCBs	4.0E-03	4.1E-03	5.3E-04	5.5E-04	1.4E-03	1.4E-03
		ABSA 10	Total PCBs	1.6E-03	4.0E-03	2.2E-04	5.4E-04	5.8E-04	1.4E-03
		ABSA 11	Total PCBs	5.7E-04	1.9E-03	7.6E-05	2.6E-04	2.0E-04	6.7E-03

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)

				Noncarcinogenic Hazard Quotient from Ingestion of Fish					
				Subsistence		Sport - Central Tendency		Sport - High End	
Source Medium	Exposure Medium	Exposure Point	Chemical	100% SMB	75% SMB/ 25% CARP	100% SMB	75% SMB/ 25% CAR	100% SMB	76% SMB/ 24% CAR
Fish	Fish	ABSA 3,4,5 (Combined)	Total PCBs	44 (R) 150 (I)	80 (R) 280 (I)	5.9 (R) 21 (I)	11 (R) 38 (I)	15 (R) 54 (I)	28 (R) 98 (I)
		ABSA 6	Total PCBs	42 (R) 150 (I)	53 (R) 190 (I)	5.6 (R) 20 (I)	7.2 (R) 25 (I)	15 (R) 51 (I)	19 (R) 65 (I)
		ABSA 7	Total PCBs	42 (R) 150 (I)	50 (R) 170 (I)	5.7 (R) 20 (I)	6.7 (R) 23 (I)	15 (R) 52 (I)	17 (R) 61 (I)
		ABSA 8	Total PCBs	48 (R) 170 (I)	62 (R) 220 (I)	6.4 (R) 22 (I)	8.4 (R) 29 (I)	17 (R) 58 (I)	22 (R) 76 (I)
		ABSA 9	Total PCBs	66 (R) 230 (I)	68 (R) 240 (I)	8.8 (R) 31 (I)	9.1 (R) 32 (I)	23 (R) 81 (I)	24 (R) 83 (I)
		ABSA 10	Total PCBs	27 (R) 96 (I)	67 (R) 240 (I)	3.7 (R) 13 (I)	9.0 (R) 32 (I)	9.6 (R) 34 (I)	23 (R) 82 (I)
		ABSA 11	Total PCBs	9.4 (R) 33 (I)	32 (R) 110 (I)	1.3 (R) 4.4 (I)	4.3 (R) 15 (I)	3.3 (R) 12 (I)	11 (R) 39 (I)

Notes: Acceptable hazard quotient: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

Table 5-3 Summary of Risks and Hazards for Residents Living Near Exposed Floodplain Soils Average Concentrations API/K/KR Site

Source Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Exposure Routes Total	Chemical	Noncarcinogenic Hazard Index: Exposure Routes Total
Floodplain Soils	Floodplain Soils	Trowbridge	Total PCBs	5.0E-05	Total PCBs	0.84 (R) 2.9 (I)
Floodplain Soils	Floodplain Soils	Otsego	Total PCBs	3.4E-05	Total PCBs	0.57 (R) 2.0 (I)
Floodplain Soils	Floodplain Soils	Plainwell	Total PCBs	4.4E-05	Total PCBs	0.74 (R) 2.6 (I)

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

Table 5-4 Summary of Risks and Hazards for Residents Living Near Exposed Floodplain Soils Maximum Concentrations API/PC/KR Site

Source Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Exposure Routes Total	Chemical	Noncarcinogenic Hazard Index: Exposure Routes Total
Floodplain Soils	Floodplain Soils	Trowbridge	Total PCBs	3.3E-04	Total PCBs	5.5 (R) 19 (I)
Floodplain Soils	Floodplain Soils	Otsego	Total PCBs	1.5E-04	Total PCBs	2.4 (R) 8.5 (I)
Floodplain Soils	Floodplain Soils	Plainwell	Total PCBs	3.5E-04	Total PCBs	5.8 (R) 20 (I)

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

Table 5-5 Summary of Risks and Hazards for Recreational Visitors to Exposed Floodplain Soils Average Concentrations API/K/KR Site

Source Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Exposure Routes Total	Chemical	Noncarcinogenic Hazard Index: Exposure Routes Total
Floodplain Soils	Floodplain Soils	Trowbridge	Total PCBs	5.3E-06	Total PCBs	0.008 (R) 0.39 (I)
Floodplain Soils	Floodplain Soils	Otsego	Total PCBs	3.6E-06	Total PCBs	0.006 (R) 0.26 (I)
Floodplain Soils	Floodplain Soils	Plainwell	Total PCBs	4.7E-06	Total PCBs	0.008 (R) 0.34 (I)

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)

Table 5-6 Summary Of Risks And Hazards For Recreational Visitors To Exposed Floodplain Soils Maximum Concentrations API/PC/KR Site

Source Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk Exposure Routes Total	Chemical	Noncarcinogenic Hazard Index Exposure Routes Total
Floodplain Soils	Floodplain Soils	Trowbridge	Total PCBs	3.5E-05	Total PCBs	0.58 (R) 2.5 (I)
Floodplain Soils	Floodplain Soils	Otsego	Total PCBs	1.5E-05	Total PCBs	0.26 (R) 1.1 (I)
Floodplain Soils	Floodplain Soils	Plainwell	Total PCBs	3.7E-05	Total PCBs	0.61 (R) 2.7 (I)

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)

Note that risks were relatively high for ABSAs 1 and 2, although still much lower than those for site ABSAs (3 through 11). These areas, upstream of the source areas associated with the API/PC/KR site, may be influenced by non-site related sources of PCBs. Fish from ABSA 2, which includes Morrow Lake behind Morrow Pond Dam, have higher average and maximum PCB concentrations than fish taken from areas further upstream.

5.3.1.2 Noncancer Hazard

Noncancer hazards to subsistence anglers were estimated for both reproductive and immunological effects. As presented in Tables 5-1 and 5-2 and Figures 5-5 through 5-8, HQs for both endpoints for all scenarios using both average and maximum EPCs exceed the regulatory HQ threshold of 1 for all ABSAs in the API/PC/KR site.

The HQ for the average exposure point scenario ranged between 6 and 37 for the reproductive endpoint and 21 and 130 for the immunological endpoint for single species ingestion. For mixed species ingestion, the HQ ranged from 18 to 37 for the reproductive endpoint and from 63 to 130 for the immunological endpoint.

The HQ for the maximum exposure point scenario ranged between 9 and 66 for the reproductive endpoint and 33 and 230 for the immunological endpoint for single species. For mixed species, the HQ ranged from 32 to 80 for the reproductive endpoint and from 110 to 280 for the immunological endpoint.

As discussed in Section 5.3.1.1, HQs for upstream ABSAs 1 and 2 are relatively high, suggesting some non-site related sources of PCBs above. HQs for ABSA 2 exceed the threshold of 1, although these HQs remain many times lower than those calculated for exposure in ABSAs 3 through 11.

5.3.2 Sport Anglers - High End

5.3.2.1 Cancer Risks

As presented on Tables 5-1 and 5-2 and Figures 5-1 through 5-4, cancer risks to high end sport anglers exceeded both EPA and MDEQ cancer risk thresholds for all ABSAs in the API/PC/KR site for both the average EPC and maximum EPC scenarios for both single and multiple species. Cancer risks for average EPCs ingesting single species were all at or above 1 in 10, 000. Cancer risks to high end sport anglers using maximum EPCs ingesting single species were all at or above 1 in 10,000 except for ABSAs 8 and 9, where risks exceeded 1 in 1,000. Cancer risks to sport anglers ingesting multiple species were in the 1 in 10,000 or higher range using average EPCs and 1 in 1,000 or higher using maximum EPCs. The highest cancer risk for high end anglers ingesting single species were estimated for ABSA 9 using average and maximum EPCs with estimated risks of 8 in 10,000 and 1 in 1,000, respectively. For multiple species ingestion, the highest cancer risks were estimated for ABSA 10 using average EPCs, and in ABSA 11 using maximum EPCs with estimated risks of 8 in 10,000 and 7 in 1,000, respectively.

As discussed in Section 5.3.1.1, risks were relatively high for ABSAs 1 and 2, although still much lower than those for site ABSAs (3 through 11). These areas, upstream of the source areas associated with the API/PC/KR site, may be influenced by non-site related sources of PCBs. Fish from ABSA 2, which includes Morrow Lake behind Morrow Pond Dam, have higher average and maximum PCB concentrations than fish taken from areas further upstream.

5.3.2.2 Noncancer Hazard

As presented in Tables 5-1 and 5-2 and Figures 5-5 through 5-8, scenarios exceeded a HQ of 1 for both the immunological and reproductive endpoints. The HQ for the average EPC scenario ranged from 2 to 13 for the reproductive endpoint and 7.5 to 46 for the immunological endpoint for single species ingestion. For mixed species, the HQ ranged between 6 and 13 for the reproductive endpoint, and 22 and 45 for the immunological endpoint for multiple species.

The HQ for the maximum EPC scenario ranged from 3 to 23 for the reproductive endpoint and from 12 to 81 for the reproductive endpoint. For mixed species, the HQ for the reproductive endpoint ranged from 11 to 28, and for the immunological endpoint ranged from 39 to 98.

As discussed in Section 5.3.1.1, HQs for upstream ABSAs 1 and 2 are relatively high, suggesting some non-site related sources of PCBs above. HQs for ABSA 2 exceed the threshold of 1, although these HQs remain many times lower than those calculated for exposure in ABSAs 3 through 11.

5.3.3 Sport Anglers - Central Tendency

5.3.3.1 Cancer Risks

As presented on Tables 5-1 and 5-2 and Figures 5-1 through 5-4, cancer risks to central tendency sport anglers exceeded both EPA and MDEQ cancer risk thresholds for both the average and maximum EPC scenarios for both single and multiple species for all ABSAs in the API/PC/KR site with two exceptions. For the single species scenario using average EPCs, cancer risks were all at or above 1 in 10,000, except for ABSAs 6 and 11 where cancer risks were at or above 1 in 100,000. For the single species scenario, cancer risks using maximum EPCs ranged from 8 in 100,000 to 5 in 10,000. For the multiple species scenario using average EPCs, cancer risks were all in the 1 in 10,000 range. For the multiple species scenario using maximum EPCs, cancer risks were all also in the 1 in 10,000 range. For the multiple species scenario, cancer risks using maximum EPCs ranged from 3 in 10,000 to 6.5 in 10,000.

As discussed in Section 5.3.1.1, risks were relatively high for ABSAs 1 and 2, although still much lower than those for site ABSAs (3 through 11). These areas, upstream of the source areas associated with the API/PC/KR site, may be influenced by non-site related sources of PCBs. Fish from ABSA 2, which includes Morrow Lake behind Morrow Pond Dam, have higher average and maximum PCB concentrations than fish taken from areas further upstream.

5.3.3.2 Noncancer Hazard

As presented on Tables 5-1 and 5-2 and Figures 5-5 through 5-8, all scenarios using both average and maximum EPCs exceeded a HQ of 1 for both the immunological and reproductive endpoints, except for ABSA 11 where the HQ for the reproductive endpoint was 0.8. The HQ for the average exposure point scenario ranged between 0.8 and 5 for reproductive endpoint and 3 and 18 for the immunological endpoint for single species. For mixed species, the HQ ranged between 2 and 5 for the reproductive endpoint and 8 and 17 for the immunological endpoint.

HQs for the maximum exposure point scenario ranged between 1 and 9 for the reproductive endpoint and 4 and 31 for the immunological endpoint for single species. For mixed species, HQs ranged between 4 and 11 for the reproductive endpoint and 15 and 38 for the immunological endpoint.

As discussed in Section 5.3.1.1, HQs for upstream ABSAs 1 and 2 are relatively high, suggesting some non-site related sources of PCBs above. HQs for ABSA 2 exceed the threshold of 1, although these HQs remain many times lower than those calculated for exposure in ABSAs 3 through 11.

5.3.4 Nearby Residents

5.3.4.1 Cancer Risks

As presented on Tables 5-3 and 5-4 and Figure 5-9, cancer risks for nearby residents in all three floodplain soil areas were in the 1 in 100,000 range using average EPCs and

in the 1 in 10,000 or higher range using maximum EPCs. Estimates using maximum EPCs exceeded both MDEQ and EPA cancer risk thresholds; estimates using average EPCs exceeded MDEQ thresholds but were within EPA target cancer risk range. The highest risks using average EPCs were estimated for the Trowbridge area at 5 in 100,000; the highest risks using maximum EPCs were estimated for the Plainwell area at 3.5 in 10,000.

5.3.4.2 Noncancer Hazard

As presented on Tables 5-3 and 5-4 and Figure 5-10, noncancer HIs for the immunological endpoint in all three areas exceeded 1 using average and maximum EPCs. HIs using average EPCs ranged from 2 to 3 for the immunological endpoint and 0.6 to 0.8 for the reproductive endpoint. Estimates using maximum EPCs ranged from 8.5 to 20 for the immunological endpoint and from 2 to 6 for the reproductive endpoint.

5.3.5. Recreationalists

5.3.5.1 Cancer Risks

As presented on Tables 5-5 and 5-6 and Figure 5-11, cancer risks for recreationalists in all three floodplain areas were in the 1 in 1 million or higher range using average concentrations and in the 1 in 100,000 or higher range using maximum concentrations. Estimates using average concentrations were within EPA target risk range and below MDEQ threshold. Estimates using maximum concentrations were within EPA target risk range, but exceeded MDEQ threshold. The highest risks using average concentrations were estimated for the Trowbridge area at 5 in 1 million. The highest risks using the maximum concentrations were estimated for the Plainwell area at 4 in 100,000.

5.3.5.2 Noncancer Hazard

As presented on Tables 5-5 and 5-6 and Figure 5-12, using average EPCs, noncancer HIs for both the immunological and reproductive endpoints were below EPA and MDEQ threshold of 1. Using maximum EPCs, HQs for the reproductive endpoint were also all below the threshold of 1. Using maximum EPCs, HIs for the immunological endpoint exceeded the threshold of 1 for Plainwell (3), Otsego (1), and Trowbridge (2.5) areas.

5.4 Summary

Risks and hazard quotients/indices for the API/PC/KR site can be summarized as follows:

- Cancer risks and HQs in both central tendency and high end sport and subsistence anglers exceed EPA and/or MDEQ risk limits for all scenarios in all ABSAs in the API/PC/KR site using both average and maximum EPCs (with the exception of CTE sport anglers consuming 100 percent bass from ABSA 11 for which the calculated HQ based on average PCB concentrations was 0.8).

- Cancer risks for residents living near the floodplain soil behind the three MDNR impoundments exceed MDEQ thresholds using both average and maximum EPCs.

- Cancer risks for residents living near the floodplain soils behind the three MDNR impoundments are within EPA target cancer risk range but above the MDEQ threshold for the average scenario.

- Cancer risks for residents living near the floodplain soils behind the three MDNR impoundments are outside MDEQ and EPA target cancer risk range using maximum EPCs.

- HIs for residents living near the floodplain soils behind the three MDNR impoundments exceed MDEQ and EPA threshold of 1 for the immunological endpoint using both average and maximum EPCs. HQs for the reproductive endpoint do not exceed a HI of 1 using average EPCs. HIs using maximum EPCs exceed MDEQ and EPA threshold of 1.0 for the Trowbridge (5.5), Otsego (2), and Plainwell (6) areas.

- Cancer risks for recreationalists on the floodplain soil behind the three MDNR impoundments are within the EPA target risk range and less than MDEQ threshold using **average EPCs**.

- Cancer risks for recreationalists on the floodplain soil behind the three MDNR impoundments are within the EPA target risk range and exceed MDEQ threshold using **maximum EPCs**.

- HIs for recreationalists on the floodplain soil behind the three MDNR impoundments are less than EPA and MDEQ threshold of 1 for both the reproductive and immunological endpoints using average concentrations.

- HIs for recreationalists on the floodplain soil behind the three MDNR impoundments are less than EPA and MDEQ threshold of 1 for the reproductive endpoint using maximum EPCs. HIs for the immunological endpoint exceeded the threshold of 1 for the Trowbridge (2.5), Otsego (1), and Plainwell (3) areas using maximum EPCs.

- Some elevated cancer risk and hazard estimates were calculated for anglers in upstream ABSAs 1 and 2. These risks and hazards were many times less than those for ABSAs 3 through 11, but still suggest some smaller sources of PCBs above the Superfund site boundaries. Risks and hazards were highest for ABSA 2, which includes Morrow Lake behind Morrow Pond Dam.